Statewide Access Management and Transportation Site Impact

WEBINAR SERIES

Webinar Staff

Gina Bonyani
Senior Transportation Planner
FDOT Systems Implementation Office
Gina.Bonyani@dot.state.fl.us
850-414-4707

SIO
SYSTEMS IMPLEMENTATION OFFICE

Agenda

Credits and Webinar Material

Crashes Related to Type and Location of Driveway Access

Contact Info

Credits Information

- Certificates will be distributed through email.
- Your participation will be recorded by GoToWebinar.
  - You will need to attend to the entire webinar with the unique link provided by GoToWebinar.

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Webinar Material

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  - Training & Webinars
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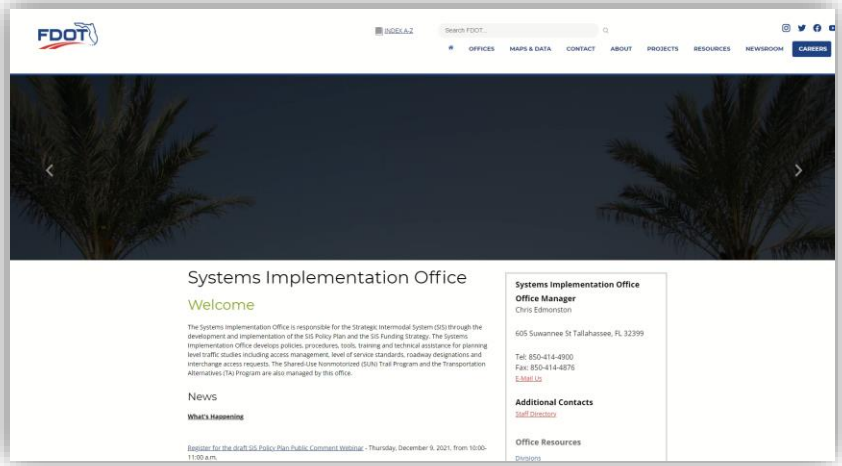

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Statewide Access Management and Transportation Site Impact

WEBINAR SERIES

The FDOT Access Management and Transportation Site Impact Webinar Series 2022-2023 have been scheduled for the following dates:

Tue, Aug 16, 2022 | 2:00PM - 3:30PM EDT
Tue, Nov 15, 2022 | 2:00PM - 3:30PM EST
Tue, Feb 14, 2023 | 2:00PM - 3:30PM EST
Next! **Tue, May 16, 2023 | 2:00PM - 3:30PM EDT**

What organization do you represent?

- FDOT
- Local Government
- Private Firm
- Other

Statewide Access Management and Transportation Site Impact

WEBINAR SERIES

Today's Webinar

Crashes Related to Type and Location of Driveway Access

Tuesday, February 14, 2022

2:00PM – 3:30 PM

Credits: 1.5

How familiar are you with FDOTs Permitting Process (Rule 14-96)

- Very Familiar
- Somewhat Familiar
- Not Familiar

How familiar are you with FDOTs Access Management spacing requirements (Rule 14-97)

- Very Familiar
- Somewhat Familiar
- Not Familiar

Speakers

Kristine M. Williams

Tia Boyd

Dr. Pei-Sung Lin

Dr. Cong Chen

Crashes Related to Type and Location of Driveway Access

Kristine Williams, FAICP (PI)
Cong Chen, PhD, PE, RSP1 (Co-PI)
Pei-Sung Lin, PhD, PE, PTOE (Co-PI)
Tia Boyd, Researcher
CUTR, University of South Florida

Gina Bonyani (PM), FDOT

Presented for
FDOT Statewide Access Management and Transportation Site Impact Webinar Series

February 14, 2023

CUTR

UNIVERSITY of SOUTH FLORIDA

Outline

1. Project Subject Background
2. Project Objectives
3. Literature Review Summary
4. Safety Assessment Methodology
5. Research Findings
6. Recommended Guidance Updates
7. Future Research Consideration

Project Subject Background

Driveways and side streets connecting to major roadways are a key source of traffic conflicts and could result in crashes among motorized vehicles, pedestrians and bicyclists.

FDOT is advancing complete streets and access management strategies

Changes to roadway and interchange design	Safety of ALL users is a key priority	Limited research on impacts of driveway type and location on safety

Need more research on relationship between driveway type, location, and safety

Commercial driveway type and location	Number and type of crashes	Roadway and interchange type	Factors related to bicycles, pedestrians, and vehicles

Findings could help FDOT improve safety for all modes in access design and permitting

Access management guidelines and requirements for corridors and interchange areas	Guidance to state and local agencies

Project Objectives

- Obtain additional research-based insight on how driveways impact safety
- Evaluate the impact of driveway type and location on crashes in Florida
- Translate the findings into guidance

Along major roadway corridors and in the vicinity of interchanges

Literature Review

- Synthesized methodologies and findings of previous studies on the relationship between driveway location and type on the number and type of driveway-related crashes
  - Driveway Density and Spacing
  - Driveway Location: Corner Clearance, Median Openings
  - Interchange Area: upstream/downstream driveway, driveway offset, vehicle and ped/bike conflicts
  - Driveway Type

Literature Review - Key Takeaways

- Relatively few studies have explored how driveway type and location may influence crash frequency and severity.
- Access density, commercial driveways or land use intensity, inadequate corner clearance are identified in the literature as factors in roadway safety.
- Little insight into other topics, such as influence of driveway design or interactions with roadway characteristics on crash frequency and severity.
- Confirmed our methodology as appropriate for the study

Safety Assessment Methodology

Data Collection

- Develop data collection plan
- Identify candidate study sites using GIS crash search
- Select study sites
- Specify data source and collection methods
- Collect data based on the data collection plan
- Perform data screening
- Finalize data sets for analysis

Assessment of Safety Effects and Risks

- Develop safety assessment methodology
- Perform comprehensive qualitative and quantitative data analyses
- Model safety effects and risks for commercial driveways on corridors and those near interchanges
- Document analysis results and major findings

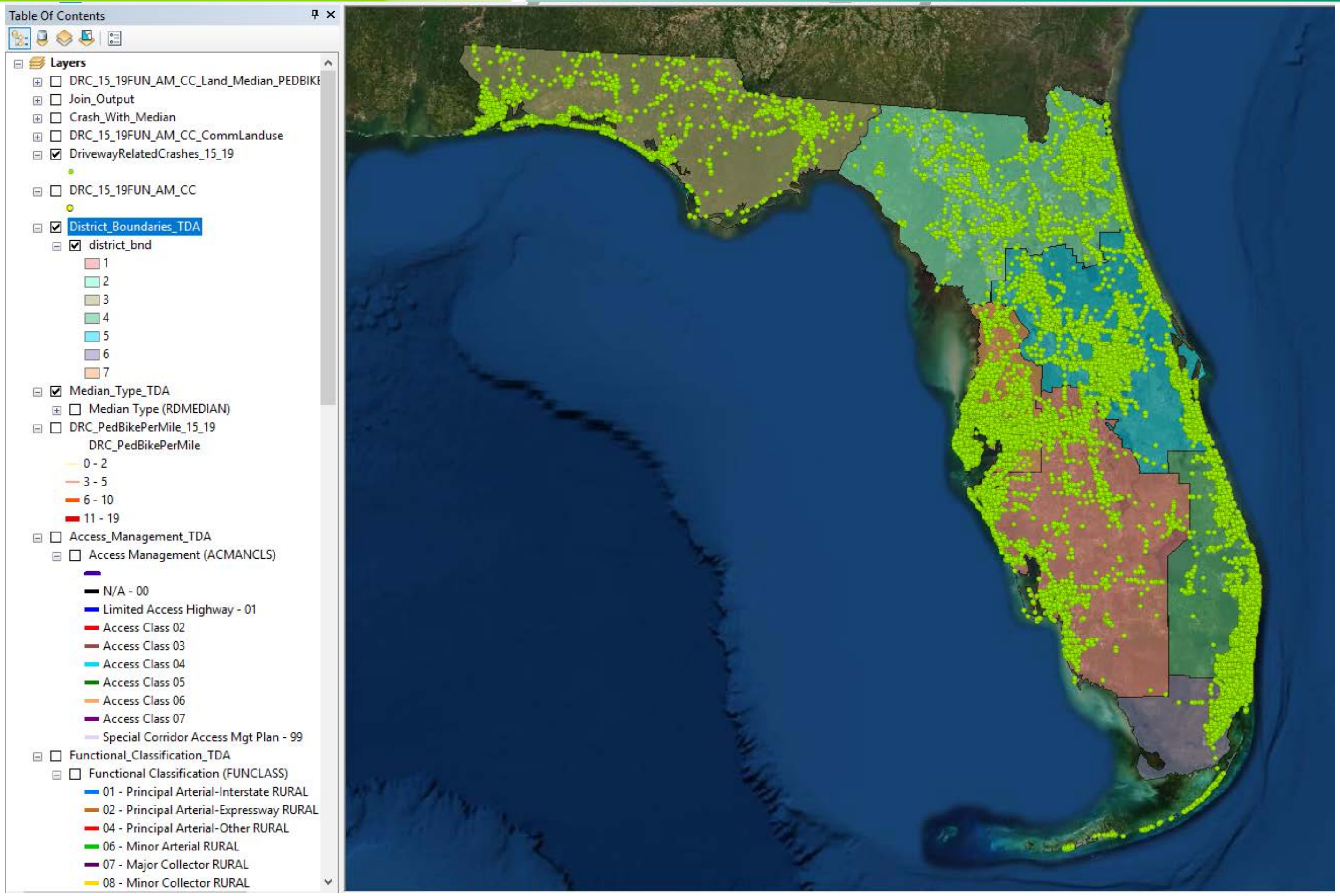
Case Studies

- Select 6 case study sites on corridors and near interchanges
- Collect data for study sites
- Review crash reports at case study sites
- Provide illustrations, descriptions and highlights

Data Used for Selecting Candidate Sites

- 2015-2019 Statewide Driveway Access Related Crash Data (Source: FDOT SSOGIS)
- FDOT Roadway Characteristics Data (Source: FDOT Transportation Data Analytics-GIS)
  - Access Classification
  - Roadway Functional Class
  - Roadway Median Type
  - Statewide Interchange Type
- Florida Statewide Land Use and Cover (Source: Florida DEP Geospatial Open Data)
  - Commercial Land Use

Corridor Driveway Site Selection Process

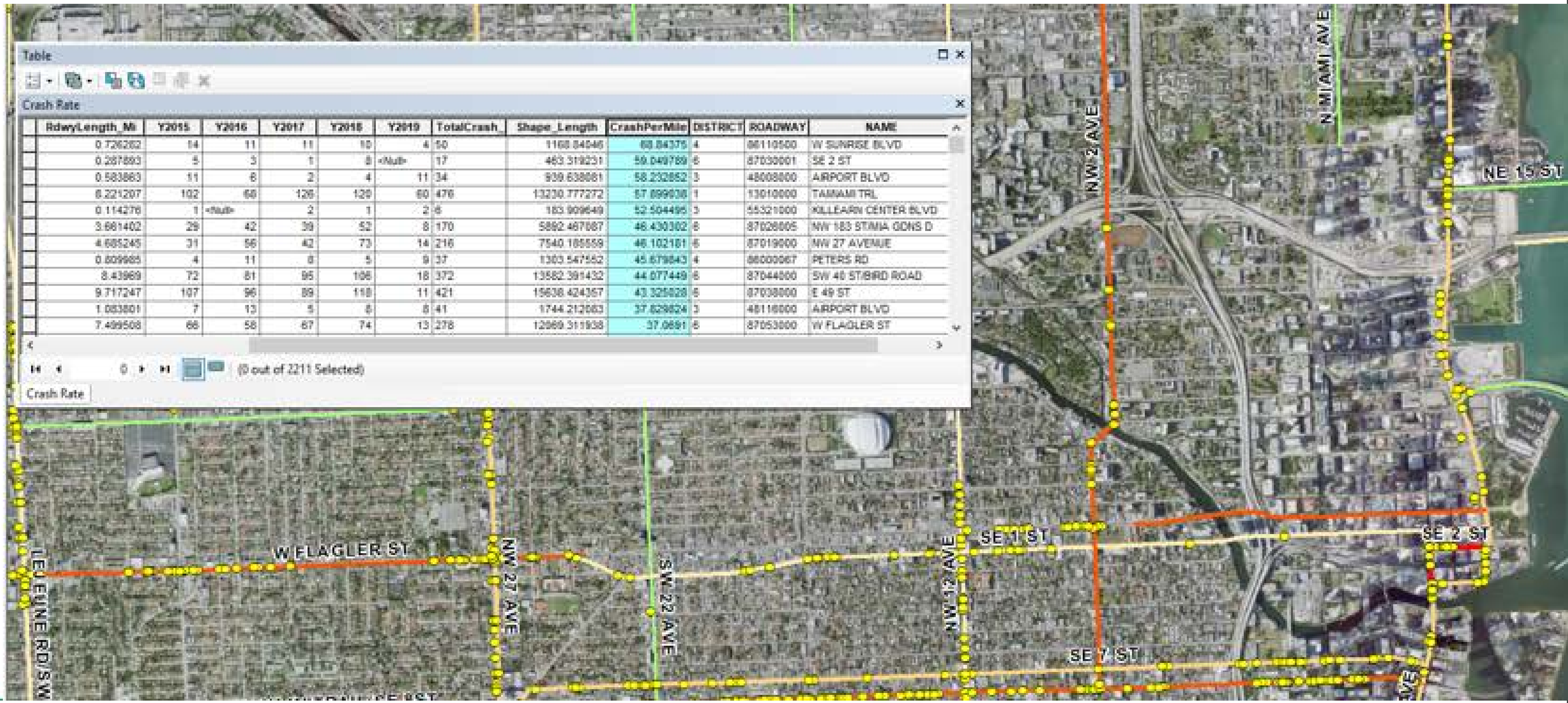


Corridor Driveway Site Selection Process

Corridor Driveway Site Selection Process

$$Crash\ Rate = \frac{No.of\ Crashes\ in\ 5\text{–}years}{Road\ Segment\ Length\ (in\ miles)}$$

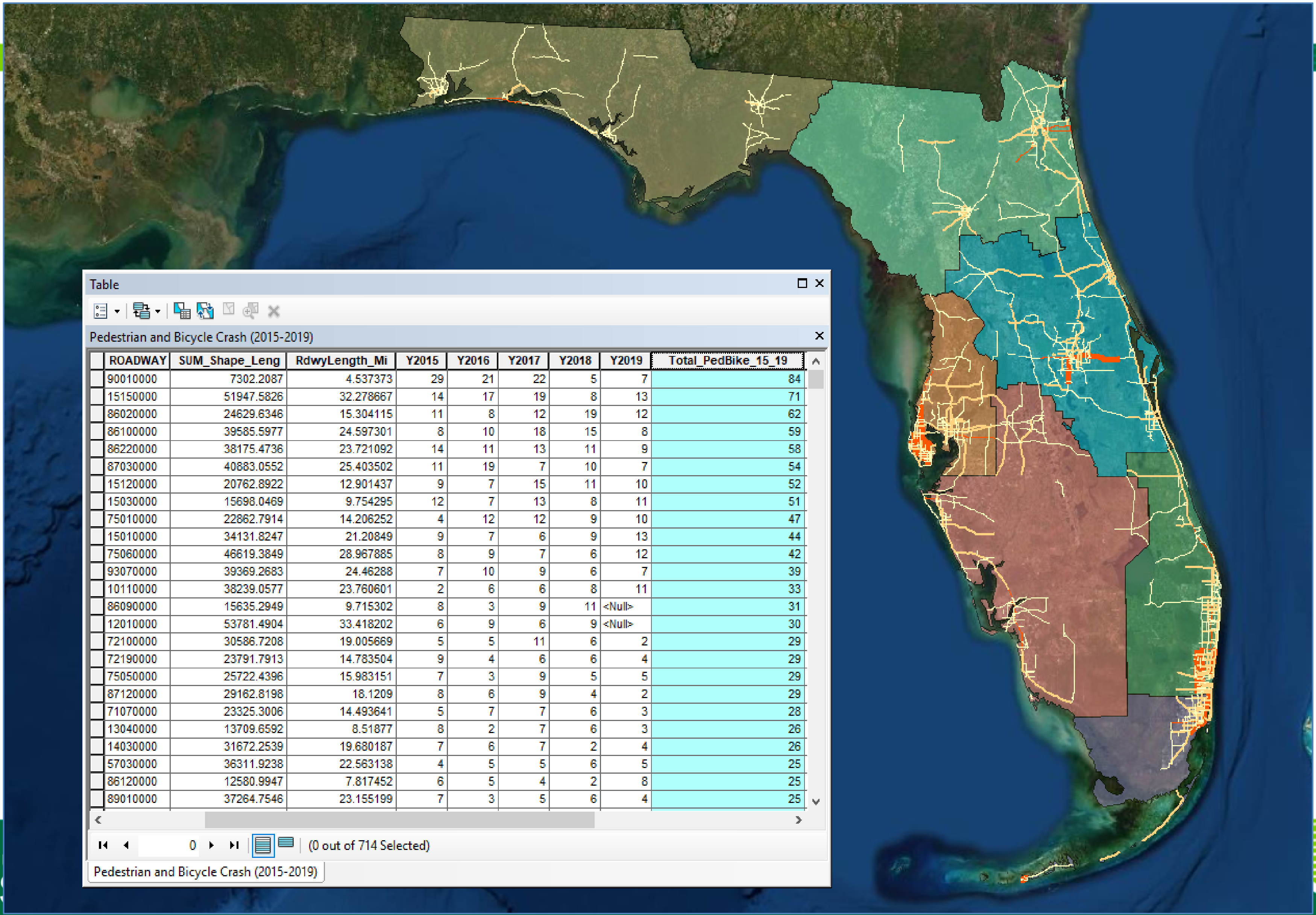
- ☑ Driveway Related Crash (2015-2019)
  - (yellow dot)
- ☑ Crash Rate
  - No. of Crashes/Segment Length (in Miles)
  - up tp 5
  - 5 to 10
  - 10 to 20
  - 20 to 30
  - 30 to 50
  - more than 50



RdwyLength_Mi	Y2015	Y2016	Y2017	Y2018	Y2019	TotalCrash_	Shape_Length	CrashPerMile	DISTRICT	ROADWAY	NAME
0.726262	14	11	11	10	4	50	1168.84046	68.84375	4	86110500	W SUNRISE BLVD
0.287893	5	3	1	8	<Null>	17	463.319231	59.049789	6	87030001	SE 2 ST
0.583863	11	6	2	4	11	34	939.638081	58.232852	3	48008000	AIRPORT BLVD
8.221207	102	68	126	120	60	476	13230.777272	57.899038	1	13010000	TAMIAMI TRL
0.114276	1	<Null>	2	1	2	6	183.909649	52.504495	3	55321000	KILLEARN CENTER BLVD
3.661402	29	42	39	52	8	170	5892.467087	46.430302	6	87026005	NW 183 ST/MIA GDNS D
4.685245	31	56	42	73	14	216	7540.185559	46.102181	6	87019000	NW 27 AVENUE
0.809985	4	11	8	5	9	37	1303.547552	45.679843	4	86000067	PETERS RD
8.43969	72	81	95	106	18	372	13582.391432	44.077449	6	87044000	SW 40 ST/BIRD ROAD
9.717247	107	96	89	118	11	421	15638.424357	43.325028	6	87038000	E 49 ST
1.083801	7	13	5	8	8	41	1744.212083	37.829824	3	48116000	AIRPORT BLVD
7.499508	66	58	67	74	13	278	12069.311938	37.0691	6	87053000	W FLAGLER ST

Corridor Driveway Site Selection Process

Additional Corridor Driveway Sites with High Ped/Bike Crashes



Table

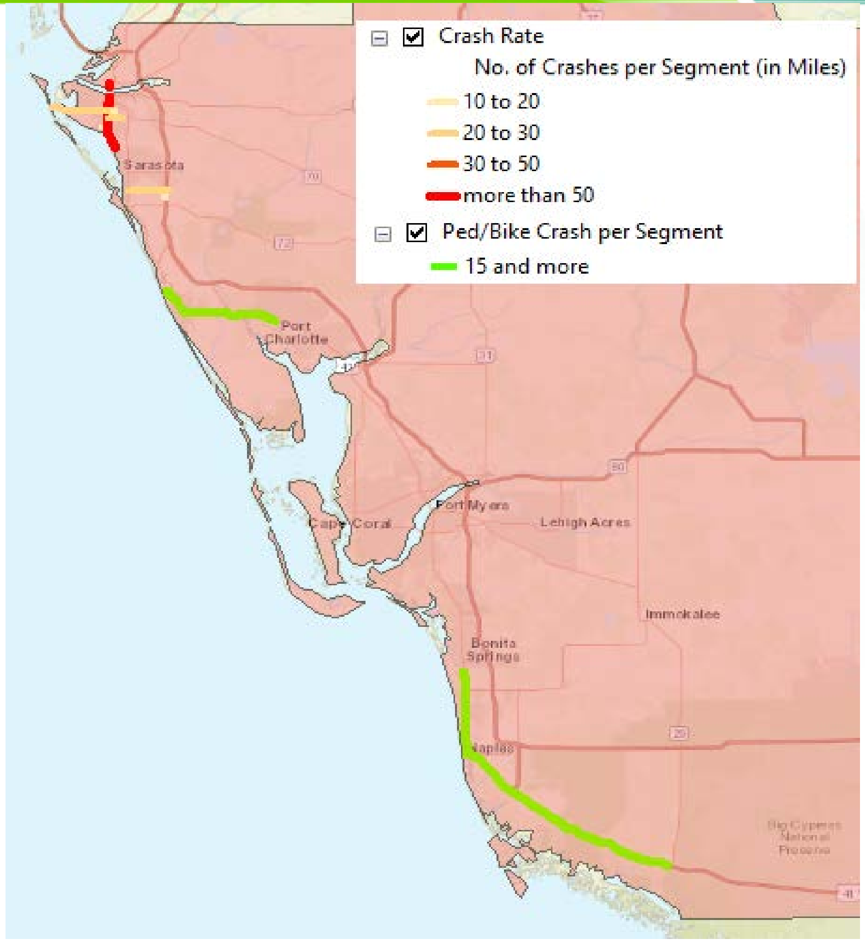
Pedestrian and Bicycle Crash (2015-2019)

ROADWAY	SUM_Shape_Leng	RdwyLength_Mi	Y2015	Y2016	Y2017	Y2018	Y2019	Total_PedBike_15_19
90010000	7302.2087	4.537373	29	21	22	5	7	84
15150000	51947.5826	32.278667	14	17	19	8	13	71
86020000	24629.6346	15.304115	11	8	12	19	12	62
86100000	39585.5977	24.597301	8	10	18	15	8	59
86220000	38175.4736	23.721092	14	11	13	11	9	58
87030000	40883.0552	25.403502	11	19	7	10	7	54
15120000	20762.8922	12.901437	9	7	15	11	10	52
15030000	15698.0469	9.754295	12	7	13	8	11	51
75010000	22862.7914	14.206252	4	12	12	9	10	47
15010000	34131.8247	21.20849	9	7	6	9	13	44
75060000	46619.3849	28.967885	8	9	7	6	12	42
93070000	39369.2683	24.46288	7	10	9	6	7	39
10110000	38239.0577	23.760601	2	6	6	8	11	33
86090000	15635.2949	9.715302	8	3	9	11	<Null>	31
12010000	53781.4904	33.418202	6	9	6	9	<Null>	30
72100000	30586.7208	19.005669	5	5	11	6	2	29
72190000	23791.7913	14.783504	9	4	6	6	4	29
75050000	25722.4396	15.983151	7	3	9	5	5	29
87120000	29162.8198	18.1209	8	6	9	4	2	29
71070000	23325.3006	14.493641	5	7	7	6	3	28
13040000	13709.6592	8.51877	8	2	7	6	3	26
14030000	31672.2539	19.680187	7	6	7	2	4	26
57030000	36311.9238	22.563138	4	5	5	6	5	25
86120000	12580.9947	7.817452	6	5	4	2	8	25
89010000	37264.7546	23.155199	7	3	5	6	4	25

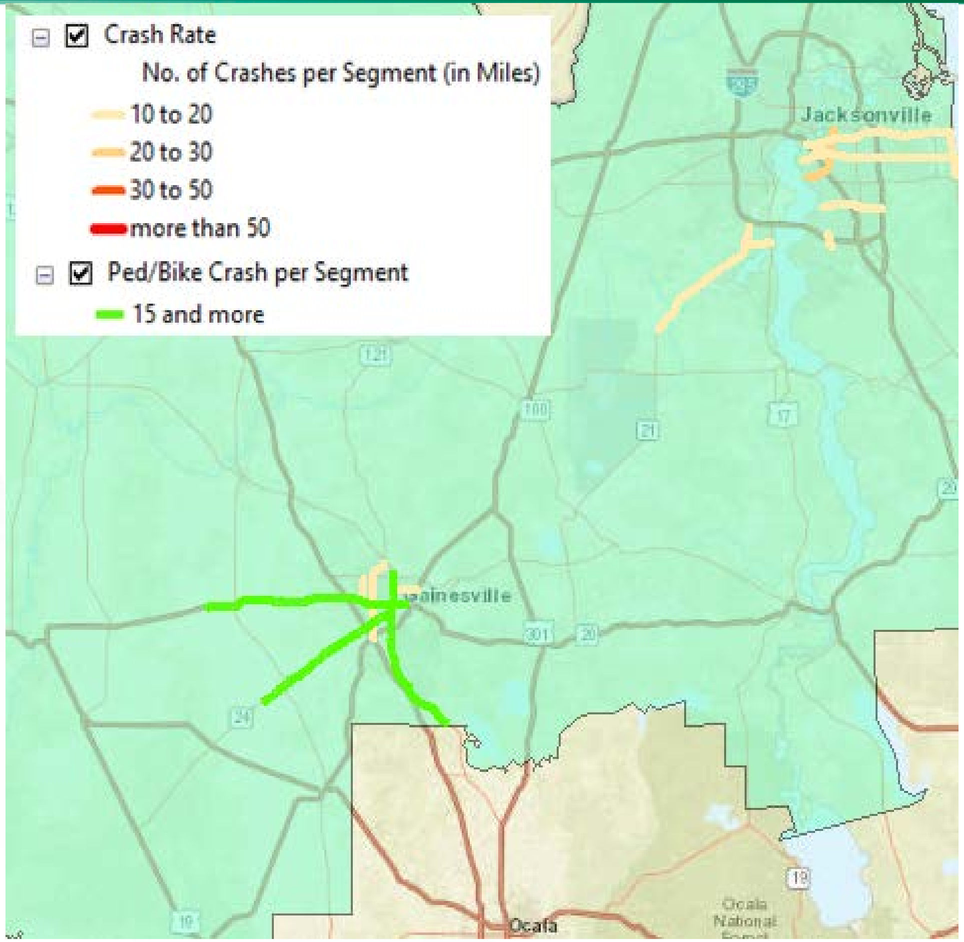
0 (0 out of 714 Selected)

Pedestrian and Bicycle Crash (2015-2019)

Corridor Driveway Sites Selected in Each District



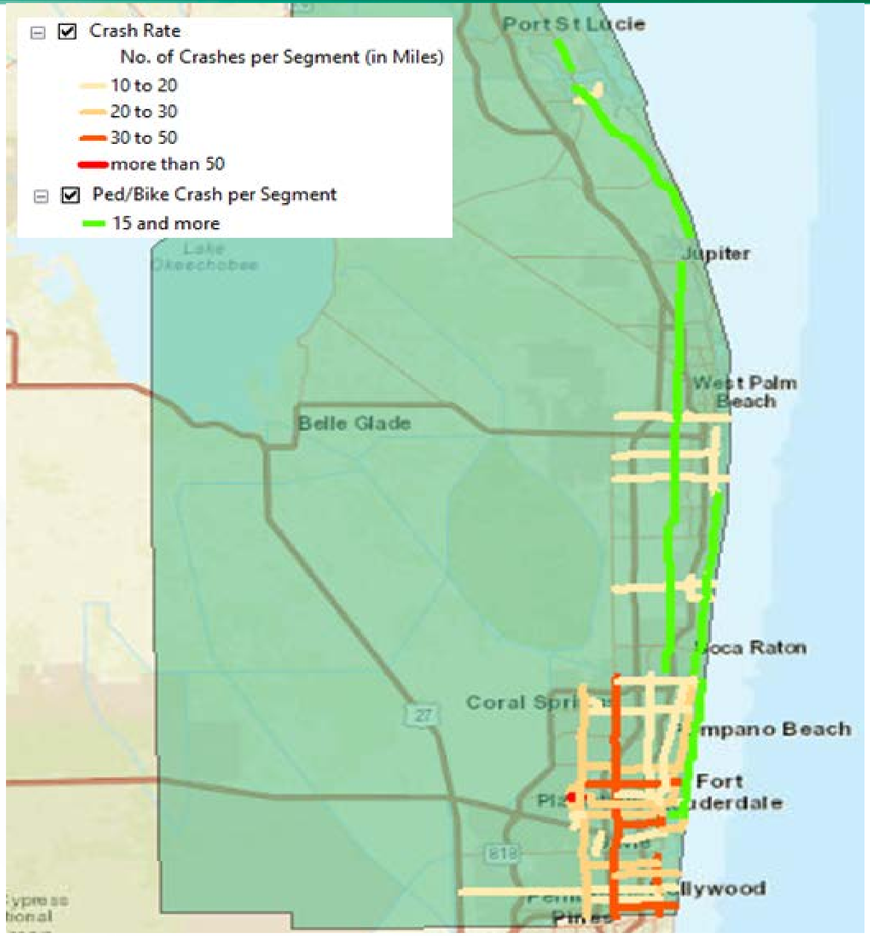
Candidate Corridors in FDOT District 1



Candidate Corridors in FDOT District 2

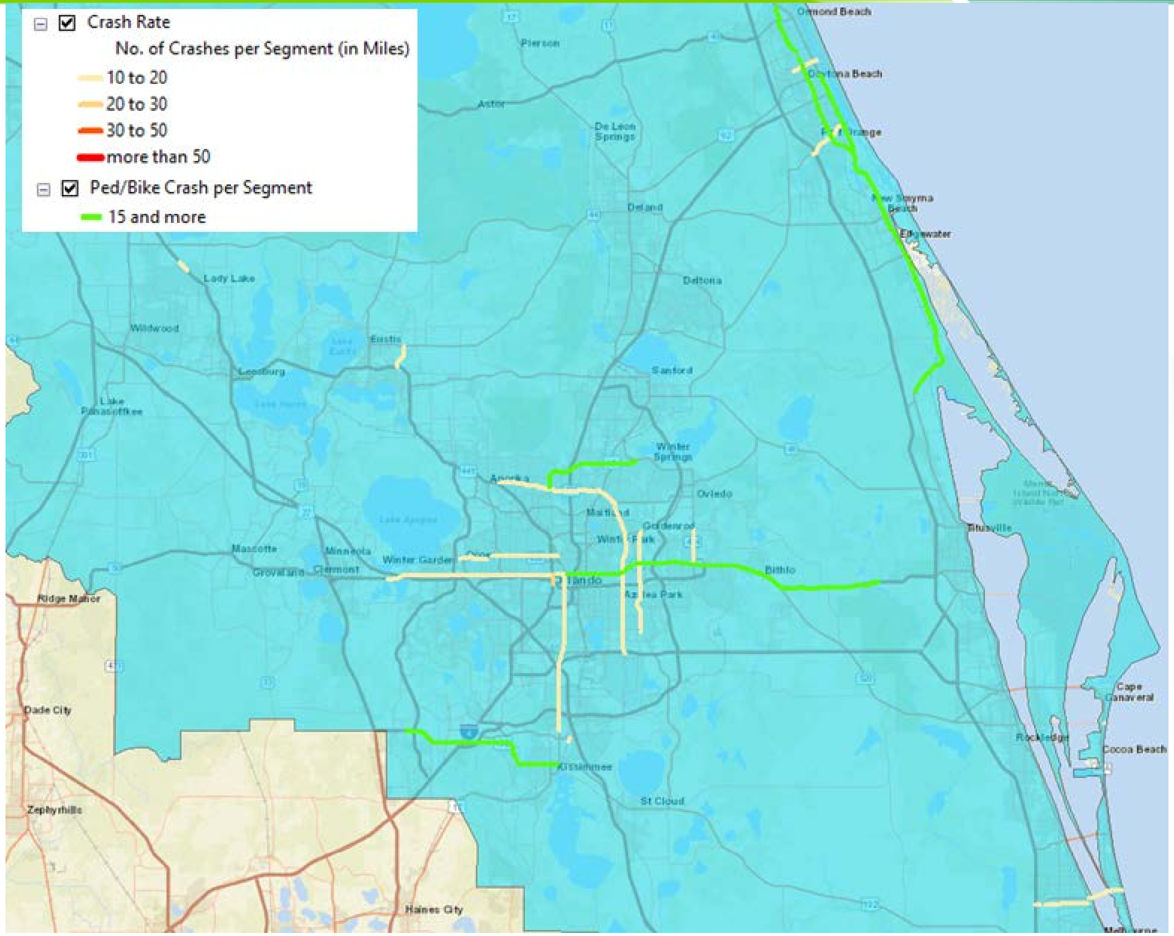
Corridor Driveway Sites Selected in Each District

Candidate Corridors in FDOT District 3

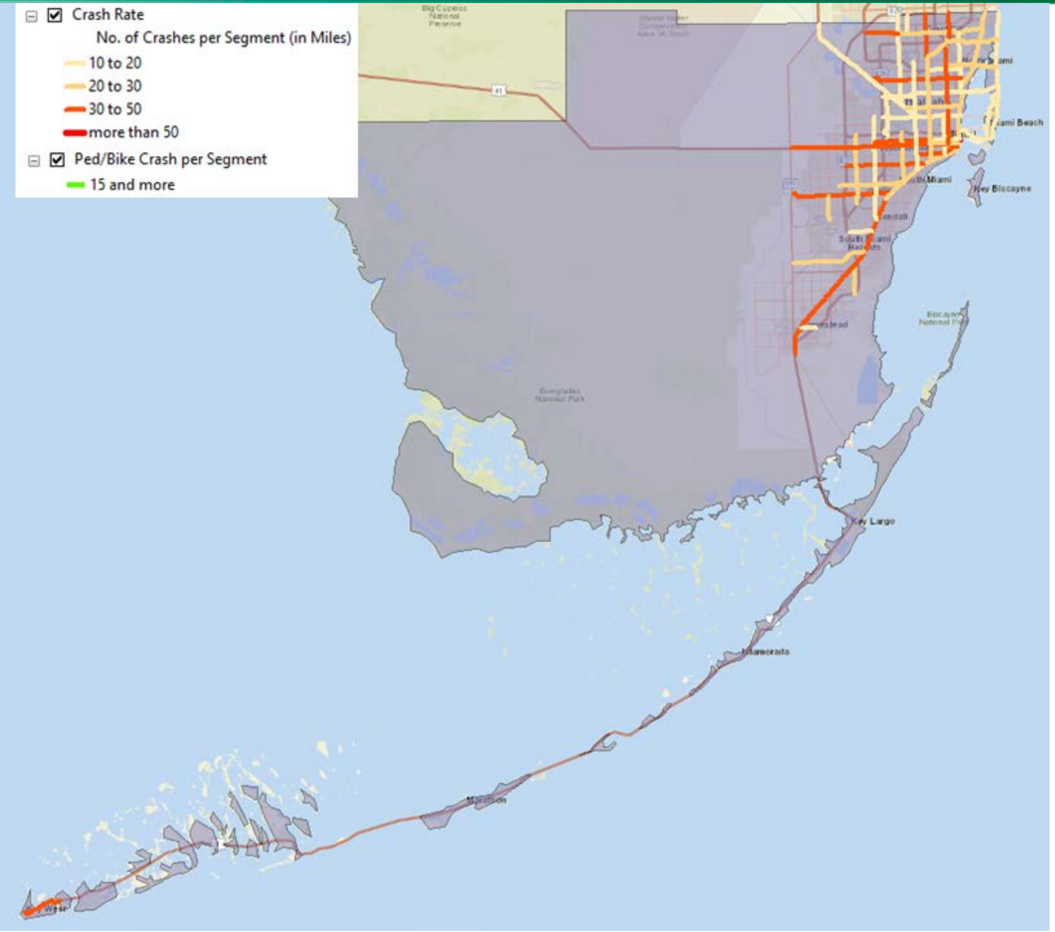


Candidate Corridors in FDOT District 4

Corridor Driveway Sites Selected in Each District

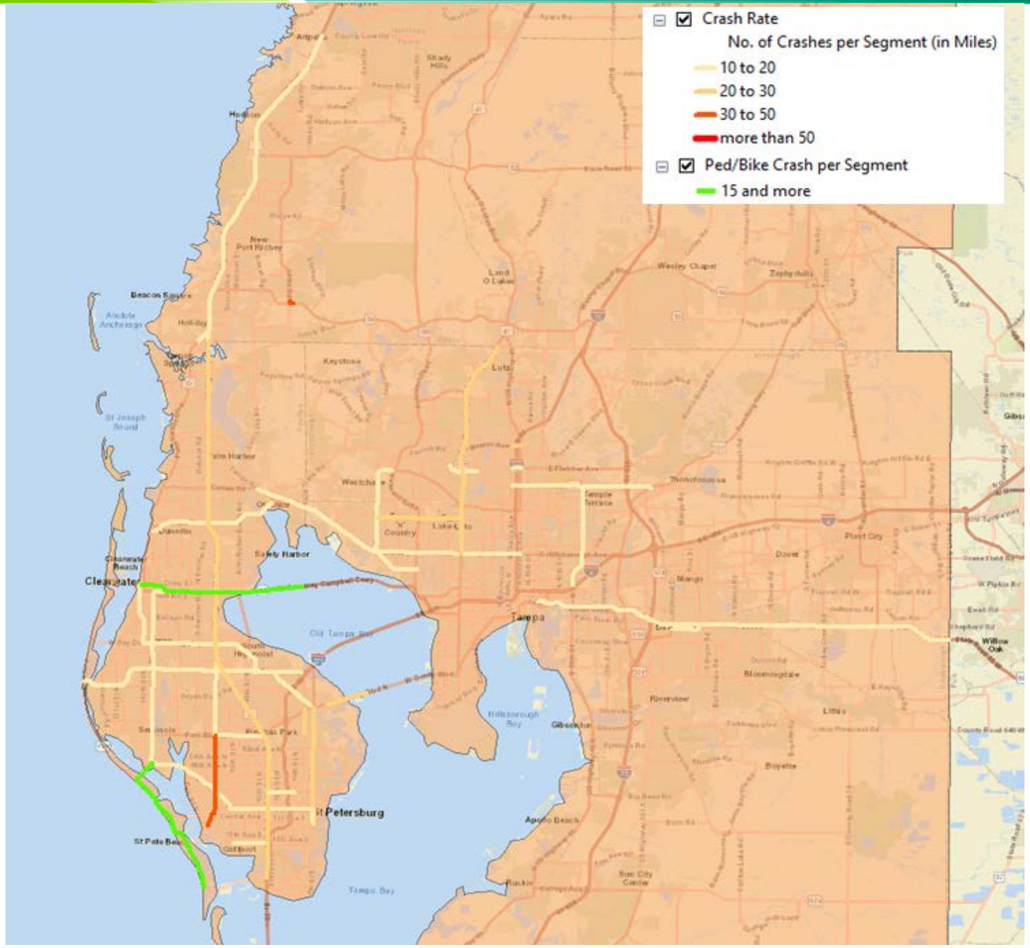


Candidate Corridors in FDOT District 5



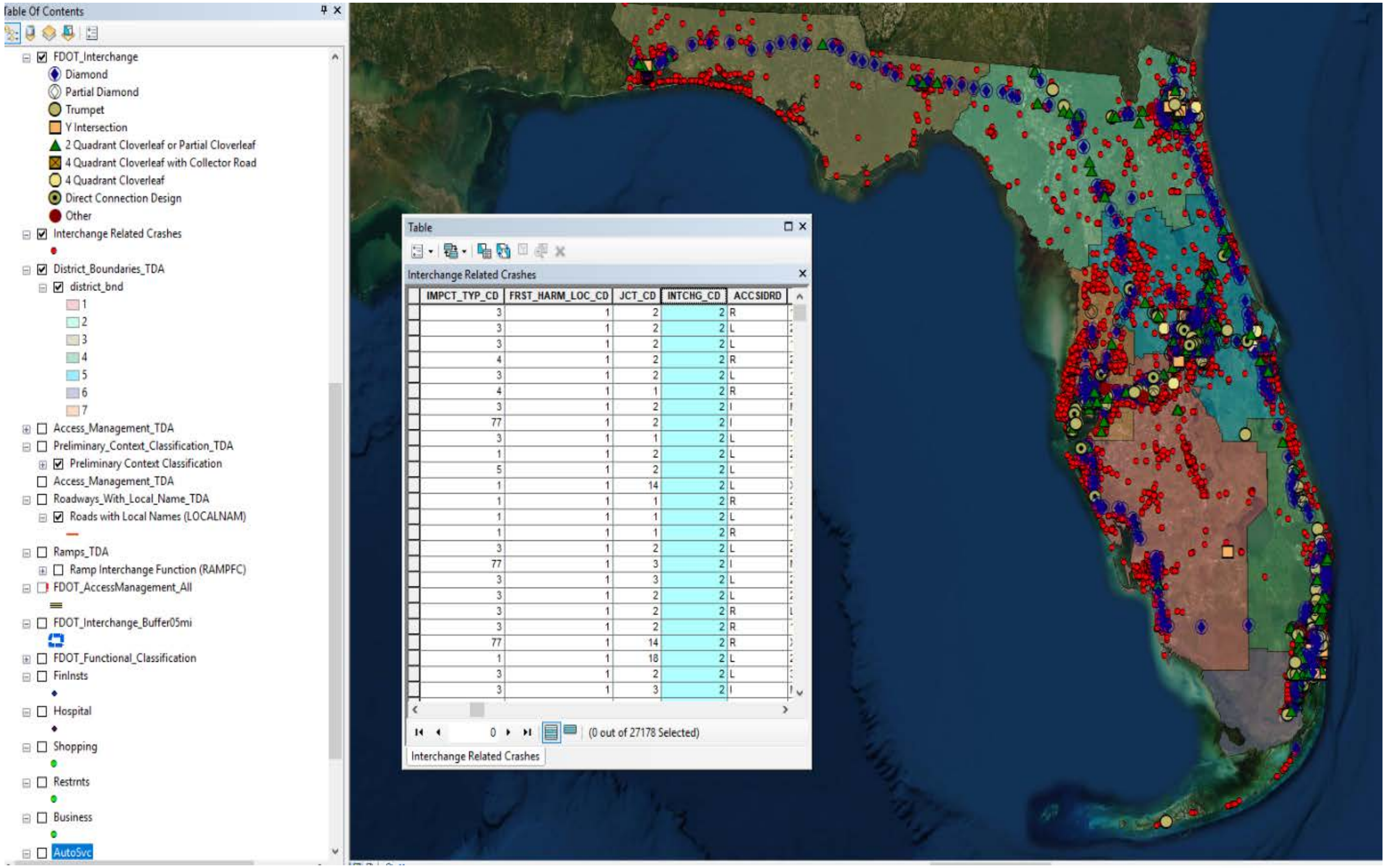
Candidate Corridors in FDOT District 6

Corridor Driveway Sites Selected in Each District

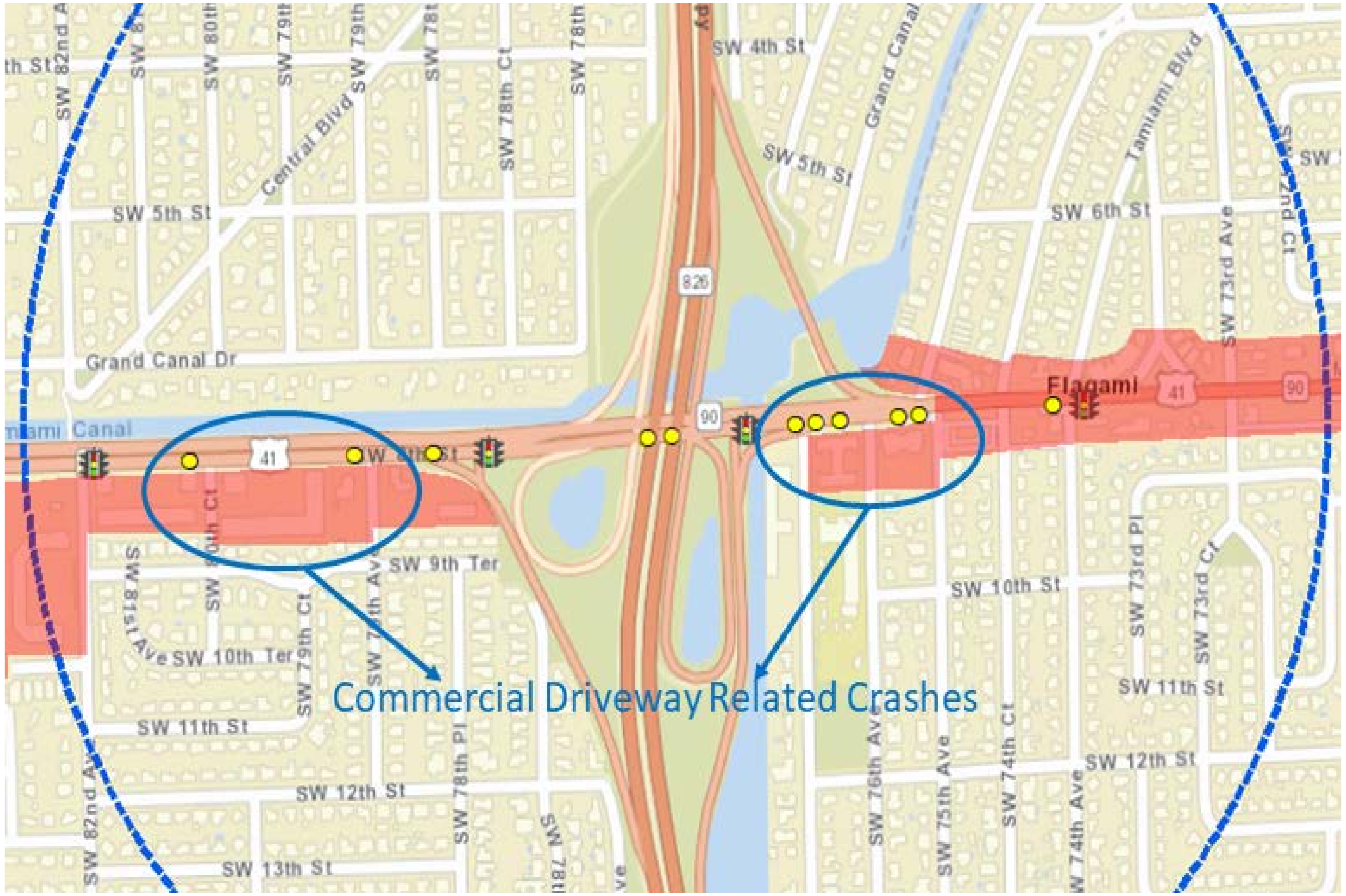


Candidate Corridors in FDOT District 7

Interchange Driveway Site Selection Process



Interchange Driveway Site Selection Process



Interchange Driveway Site Selection Process

Data Collection for Analysis

- **Roadway Data**
  - Roadway functional classification
  - FDOT context classification
  - Access class information
  - Interchange type (i.e., diamond, full cloverleaf, partial cloverleaf, diverging diamond)
- **Traffic Volume Data (AADT)**
- **2015-2019 Driveway-related Crash Data**
  - Commercial driveways along corridors
  - Commercial driveways near interchanges (.5 mile or first signalized intersection)
- **Driveway Characteristics Data**
  - Driveway location (i.e., intersection functional area, roadway segment)
  - Driveway geometric characteristics (i.e., number of lanes, radius/flare, channelization, driveway throat length)
  - Driveway entry and exit movements (i.e., one-way, two-way, right-in/right-out)
  - Median opening type (i.e., full opening, directional opening, no opening)
  - Median end treatment (i.e., no left-turn lane, one left-turn lane, two left-turn lanes)
  - Traffic control information

Data Sources

Crash
- Signal Four Analytics
- FDOT SSOGIS

Geometry
- FDOT GIS inventory
- Google Earth Aerial Images
- FDOT Access Class KMZ file

Analysis Methods

- Detailed data analysis and safety assessment of:
  - Crash types (vehicular and ped/bike crashes) and severities
  - How commercial driveway types interact with roadway and interchange characteristics relative to safety and crash risk.
- Statistical analysis of differences in crash frequency and crash severity by driveway type and study area (interchange and corridor)
- Crash data modeling to quantify safety effects of selected variables on crash frequency and severity of targeted crash types
  - Negative binomial model (crash frequency analysis, for both vehicular and ped/bike crashes)
  - Multinomial logit model (crash severity analysis, for both vehicular and ped/bike crashes)
- Exploratory case studies

Research Findings

Crash Frequency Analysis Summary

- Overall, variables found to have a significant influence on commercial driveway-related crashes were:
  - Number of lanes on connecting street, driveway design, driveway number of lanes, traffic control devices, and bike lane type.
- On corridors, significant variables for driveway-related crashes were:
  - Median type (undivided/painted, NTM, TWLTL) for all crashes.
  - Median opening type (no physical median, no opening, directional, full opening) for ped/bike crashes.
- Near interchanges, significant variables for driveway-related crashes were:
  - Right-turn lane type (exclusive, shared, or no right turn lane)

All Crash Frequency at Commercial Driveways - Corridors

- Driveway crashes along corridors tend to:
  - increase as number of lanes on connecting street increases
  - increase as number of driveway lanes increases
  - increase as AADT increases, but not always significantly
  - decrease as speed limit increases
  - decrease with non-traversable median and TWLTL
  - driveway design features show mixed effects (radial design have more crashes than flare; wide open access have fewer crashes than flare)

Crash Frequency at Commercial Driveways along Corridors (All Crashes)

Variables	Categories	Statistically Significant**	Crash Frequency	Notes
Number of Lanes on Connecting Street	One Lane*			
	Two Lanes	Yes	+65.2%	Number of lanes is a surrogate for roadway AADT. More lanes indicate increased lane changing behavior and potential for traffic conflicts.
	Three Lanes	Yes	+118.0%	
	Four Lanes or More	Yes	+192.9%	
Speed Limit on Connecting Street	35mph or lower*			
	40-45mph	Yes	-15.2%	Higher speed limits usually indicate higher levels of access control, whereas lower speed limits generally indicate higher access densities and more complex traffic.
	50mph or higher	Yes	-44.9%	
Driveway Design Features	Curb Flare*			
	Flush Radial	Yes	+39.8%	Flared curbed driveways generally have low driveway traffic; flush or curb radial designs are more common at higher traffic driveways as they allow for efficient ingress and egress; however, they can also increase crash risk.
	Curb Radial	Yes	+24.7%	
	Wide Open Access	Yes	-37.4%	
Driveway Number of Lanes (including both directions if available)	One Lane*			
	Two Lanes	Yes	+26.5%	Driveway number of lanes is a surrogate measure for driveway volume. Multi-lane or wide-open driveways can experience more complex traffic movements with increased potential for conflicts.
	Three Lanes	Yes	+179.1%	
	Four Lanes or more or Wide-open Access	Yes	+57.5%	
Median Type	Undivided or Painted Median*			
	Non-traversable Median	Yes	-19.9%	Both non-traversable medians (NTM) and continuous Two-Way Left-Turn Lanes (TWLTL) reduce crash risk compared to undivided roadways. NTMs tend to serve higher-volume roads and have different levels of conflict depending on median opening spacing, location, and type.
	TWLTL	Yes	-24.7%	TWLTLs provide space for vehicles to maneuver and stop as they turn or merge into traffic without blocking through lanes, but allow more conflicts than NTMs.
Connecting Street 5-year Average AADT	AADT<10,000*			
	(10,000, 20,000]	No	N/A	The average number of crashes tended to increase for all AADT categories, but only one category is found statistically significant.
	(20,000, 30,000]	No	N/A	
	(30,000, 40,000]	Yes	+258.1%	
	(40,000, 50,000]	No	N/A	
	(50,000, 60,000]	No	N/A	
	(60,000, 70,000]	No	N/A	

*Indicates base category for analysis of each variable.
**Significant at 95% confidence level.

Ped/Bike Crash Frequency at Commercial Driveways - Corridors

- Ped/bike crashes at driveways along corridors tend to:
  - o increase with sign control or signal control versus no control
  - o increase with presence of conventional bike lane compared to no bike lane
  - o decrease when there is a median with no opening or directional opening
  - o driveway design features show mixed effects

Pedestrian/Bicycle Crash Frequency at Commercial Driveways along Corridors

Variable	Values and Base Category	Statistically Significant**	Crash Frequency (±%)?	Note
Number of Lanes on Connecting Street	**One Lane***			
	Two Lanes	No	N/A	The variable is significant in explaining crash frequency; however, none of the categorical values are statistically significant relative to the base category. More lanes entail longer crossing times and greater exposure of pedestrians or bicyclists to through-traffic conflicts.
	Three Lanes	No	N/A	
	Four Lanes or More	No	N/A	
Driveway Design Feature	**Curb Flare***			
	Flush Radial	Yes	-52.0%	Radial return designs are generally used on high-volume driveways, which have higher crash potential. On flush shoulder roadways, FDOT prefers sidewalk placement outside the clear zone or five feet beyond the shoulder pavement to provide adequate protection for pedestrians or bicyclists.
	Curb Radial	Yes	+35.2%	
	Wide Open Access	No	N/A	
Median Opening Type	**No Physical Median***			
	No Opening	Yes	-21.3%	Physical medians (both no opening and directional opening) provide buffer space for pedestrians and cyclists to wait to cross, reducing collision risk with through traffic. No median opening or a directional median opening limits vehicular turning movements thereby also reducing driveway conflicts.
	Directional Opening	Yes	-36.9%	
	Full Opening	No	N/A	
Traffic Control Device	**No Control***			
	Sign Control	Yes	+52.2%	Driveways with sign or traffic signal controls tend to have higher traffic volume and more complex traffic than locations with no traffic controls, and therefore experience higher crash frequencies.
	Traffic Signal Control	Yes	+137.9%	
Painted Bike Lane	**No Bike Lane***			
	No Paint	Yes	+39.7%	Conventional bike lanes without paint do not necessarily provide protection. Motor vehicles must cross bike lanes to enter or exit driveways, leading to conflicts with bicyclists in the bike lane.
	Painted	No	N/A	

* Indicates base category for analysis of each variable.
** Significant at 95% confidence level.

All Crash Frequency at Commercial Driveways near Interchanges

- Vehicular crashes at driveways near interchanges tend to:
  - o increase as the number of lanes on connecting street increases, but not all significant;
  - o increase with shared right-turn lane or no right-turn lane, compared to exclusive right-turn lane
  - o increase with curb radial driveway design
  - o increase as the number of driveway lanes increases
  - o decrease when a bike lane is available (regardless of the colored paint)
  - o decrease as AADT increases on connecting street

Crash Frequency at Commercial Driveways near Interchanges

Variable and Base Category	Values and Base Category	Statistically Significant**	Crash Frequency***	Note
Number of Lanes on Connecting Street	**One Lane***			
	Two Lanes	No	N/A	Number of lanes is a surrogate for roadway AADT; More lanes indicate increased lane changing behavior and potential conflict points.
	Three Lanes	Yes	+87.8%	
	Four Lanes or More	Yes	+113.5%	
Right-turn Lane Type	**Exclusive Right-turn Lanes***			
	Shared/continuous right-turn lane	Yes	+99.1%	Compared to exclusive right-turn lanes, shared right-turn lanes or locations with no right-turn lane serve more than one driveway site, leading to lower driver expectancy as to where turns will occur and creating a higher potential for conflicts and rear-end collisions.
	No Right-turn Lane	Yes	+177.9%	
Driveway Design Feature	**Curb Flare***			
	Flush Radial	No	N/A	Both flare and curb radial tend to increase crash frequency but only curb radial design had a significant influence. Flush or curb radial are used at higher traffic driveways, and large radius or flare allows for quick and more efficient ingress and egress but increases crash risk.
	Curb Radial	Yes	+93.9%	
	Wide Open Access	No	N/A	
Driveway Number of Lanes (including both directions if available)	**One Lane***			
	Two Lanes	No	N/A	Driveway number of lanes could be a surrogate measure for driveway volume; Driveways with multiple lanes or wide-open access can experience more complex traffic movements with increased potential
	Three Lanes	Yes	+148.8%	
	Four Lanes or more or Wide-open Access	Yes	+133.8%	
Traffic Control Device	**No Control***			
	Sign Control	Yes	+34.8%	Locations with sign control tend to have higher traffic volume and more complex traffic than location with no traffic controls, and therefore still experience higher crash frequencies.
	Traffic Signal Control	No	N/A	
Bike Lane Type	**No Bike Lane***			
	Conventional Bike Lane	Yes	-26.8%	Other bike lane types were also found to decrease crash frequency but not significantly. Therefore, presence of a bike lane at commercial driveways near interchanges helps to reduce crash frequency, regardless of bike lane type.
	Other Bike Lane Types	No	N/A	
Connecting Street 5-year Average AADT	**AADT≤10,000***			
	(10,000, 20,000]	Yes	-46.1%	It is possible that fewer driveways were permitted in the interchange influence area as the AADT increased on connecting streets, thereby reducing the average number of driveway-related crashes.
	(20,000, 30,000]	Yes	-61.9%	
	(30,000, 40,000]	Yes	-54.9%	
	(40,000, 50,000]	Yes	-56.3%	
	(50,000, 60,000]	Yes	-58.2%	

Crash Severity Analysis Findings Summary

- Variables significant in explaining injury severity of more than one crash group include:
  - Speed limit on connecting street, driveway design features, driveway number of lanes, driveway channelization, driveway throat length, bike lane type, connecting street AADT
- In the same crash group, some variables were significant in explaining more than one injury severity level.
  - Driveway throat length, for example, is significant in explaining minor injury and severe injury/fatality for all crashes at driveways along corridors.
- A few other crash-related variables (e.g., type of shoulder, alcohol/drug involvement, lighting conditions) were confirmed to have significant influence on crash severity.

All Crash Severity Analysis - Corridors

- **Increased severe injury/fatality risk**: 1) shoulder curb; 2) short driveway throat length
- **Decreased severe injury/fatality risk**: 1) rain weather; 2) daylight condition; 3) lower speed limit; 4) shared right-turn lane; 3) curb flare; 4) channelized driveway; 5) no median opening
- **Increased minor injury risk**: 1) unpaved shoulder or curb; 2) cloudy weather; 3) flush radial; 4) full traffic movement at driveway; 5) short driveway throat length; 6) 60K -70K AADT on connecting street
- **Decreased minor injury risk**: 1) lower speed limit; 2)curb flare; 3) left-in/out driveway; 4) no exclusive bike lane; 5) conventional bike lane; 6) lighting condition

Crash Severity at Commercial Driveways along Corridors

Crash Variable	Significant Categorical Value (Severity Level)*	Quantitative Influence (on Specific Severity Level)	Note
Type of Shoulder	Unpaved Shoulder (MI)	+16.4% (MI)	Vehicular traffic near interchanges is often relatively high speed, and turning at driveways may lead to hitting or running over the curb, causing minor injury collisions.
	Curb (MI, SI)	+33.6% (MI) +79.3% (SI)	
Weather Condition	Cloudy (MI)	+12.1% (MI)	Drivers may be more cautious and drive at relatively slower speeds in inclement weather, thereby reducing the potential for severe crashes.
	Rain (SI)	-59.3% (SI)	
Lighting Condition	Daylight (SI)	-29.8% (SI)	Daylight or sufficient lighting ensures good visibility and reduce crash severity.
Speed Limit on Connecting Street	35 mph or lower (MI, SI)	-27.5% (MI) -69.9% (SI)	Lower speed limits create less kinetic energy upon collision thereby reducing impact on the body.
	40-45 mph (MI, SI)	-18.1% (MI) -43.6% (SI)	
Right-turn Lane Type	Shared/continuous right-turn lane (SI)	-35.3% (SI)	Drivers tend to travel at lower speeds on shared right-turn lanes while attempting to locate their target driveway.
Driveway Design Feature	Flush Radial (MI)	+20.5% (MI)	Flush radial design is generally used to allow efficient (higher-speed) turning movements.
	Curb Flare (MI, SI)	-15.6% (MI) -43.0% (SI)	Curb flare design generally indicates lower driveway traffic and curb delineation at driveway sites forces drivers to slow down.
Driveway Traffic Operations	Full Traffic Movements (MI)	+17.3% (MI)	Full traffic movement driveways increase the potential risk of minor injuries.
	Left-in/Left-out (MI)	-34.5% (MI)	Left-in/left-out only driveways have fewer potential conflicts than full movement driveways.
Driveway Channelization	With Channelization (SI)	-19.8% (SI)	This result verifies the protective effects of driveway channelization by separating opposing traffic flows and preventing encroachment.
Bike Lane Type	No Exclusive Bike Lane (MI)	-23.6% (MI)	A conventional bike lane reduces minor injury crashes, but absence of a bike lane also has this effect, perhaps due to sidewalk use. Severe injury crashes are not reduced as vehicles in the adjacent through lane may still easily encroach into the bike lane and a conventional bike lane across a driveway entrance may also increase the rear-end or angle-collision risk, thereby inducing more injuries.
	Conventional Bike Lane (MI)	-20.6% (MI)	
Driveway Throat Length	Short Driveway Throat Length (MI, SI)	+4.7% (MI) +60.5% (SI)	This result verifies the safety importance of sufficient driveway throat length.
Median Opening Type	No Opening (SI)	-44.5% (SI)	No openings in the physical median prevent left-turn movements, thereby significantly reducing the potential for severe injuries.
Connecting Street AADT at Crash Year	(60,000, 70,000] (MI)	+17.0% (MI)	Only this AADT categorical value was statistically significant in explaining crash severity outcomes.

* Variable that is significant in explaining the potential of the specific injury severity level listed in the parenthesis.
** Percentage value of influence in increasing (+) or decreasing (-) the risk of specific crash severity level in the parenthesis.

Ped/Bike Crash Severity at Commercial Driveways along Corridors

- **Increased severe injury/fatality risk**: 1) alcohol or drug involvement, 2) two-lane driveway; 3) four-or-more-lane driveway or wide-open access; 4) short driveway throat length
- **Decreased severe injury/fatality risk**: 1) paved shoulder
- **Increased minor injury risk**: 1) 50k-60k AADT on connecting street; 2) paved shoulder
- **Decreased minor injury risk**: 1) paved shoulder; 2) two-lane driveway; 3) no bike lane (may however increase severe injury/fatality risk)

Pedestrian/Bicycle Crash Severity at Commercial Driveways along Corridors

Crash Variable	Significant Categorical Value (Severity Level) *	Quantitative Influence (on Specific Severity Level)**	Note
Type of Shoulder	Paved Shoulder (MI, SI)	-2.0% (MI) -37.6% (SI)	Paved shoulders should be considered near commercial driveways in areas with high pedestrian/bicycle activity.
Alcohol or Drug Involvement	Alcohol or Drug Involved (SI)	+208.95% (SI)	Although not specific to access management, this verifies the serious adverse impact of substance use on traffic safety.
Driveway Number of Lanes	Two Lanes (MI, SI)	-1.4% (MI) +162.2% (SI)	Multiple driveway lanes suggest more complex traffic conditions, relatively higher vehicle speeds, and more pedestrian/bicycle exposure, therefore inducing severe injury.
	Four Lanes or More OR Wide-open Access (SI)	+231.5% (SI)	
Bike Lane Type	No Bike Lane (MI)	-8.8% (MI)	If no bike lane is available, many bicyclists travel on the sidewalk to avoid mainstream traffic; if they travel next to the travel lane severe injuries or fatalities are likely when a crash occurs.
Driveway Throat Length	Short Driveway Throat Length (SI)	+46.4% (SI)	Sufficient driveway throat length at commercial driveways is important to pedestrian and bicycle safety along corridors.
Connecting Street AADT at Crash Year	(50,000, 60,000] (MI)	+15.5% (MI)	Only this AADT categorical value was statistically significant in explaining crash severity outcomes.

* Variable that is significant in explaining the potential of specific injury severity level listed in the parenthesis.

** Percentage value of influence in increasing (+) or decreasing (-) the risk of specific crash severity level in the parenthesis.

All Crash Severity at Commercial Driveways near Interchanges

- **Increased severe injury/fatality risk**: 1) one-lane driveway; 2) distance from taper end to each unsignalized driveway or signalized intersection is less than 500 ft
- **Increased minor injury risk**: 1) alcohol or drug involvement; 2) dawn/dusk lighting condition; 3) speed limit 50 mph or higher; 4) conventional bike lane

Motor Vehicle Crash Severity at Commercial Driveways near Interchanges

Crash Variable	Significant Categorical Value (Severity Level Explained)*	Quantitative Influence (on Specific Severity Level)**	Note
Alcohol or Drug Involvement	Alcohol or Drug Involved (MI)	+170.9% (MI)	This verifies the serious adverse impact of substance use on traffic safety.
Lighting Condition	Dawn/Dusk (MI)	+74.6% (MI)	Sufficient lighting ensures good visibility and improves traffic safety, while dawn/dusk is often associated with fatigue or drowsiness.
Speed Limit on Connecting Street	50 mph or higher (MI)	+101.3% (MI)	Speed limit is an indicator of traffic operating speed, and higher speed limits suggest a greater impact upon vehicle collision.
Driveway Number of Lanes	One Lane (SI)	+180.6% (SI)	One-lane driveways are difficult to identify due to narrow widths, and sudden maneuvers upon entry (or potential for lack of compliance on site) may increase severe injury crashes. Warning or guidance signs may be needed.
Bike Lane Type	Conventional Bike Lane (MI)	+24.3% (MI)	Conventional bike lanes do not provide a physical barrier or buffer to sufficiently reduce exposure to nearby traffic, and therefore increase the injury risk to bicyclists.
Distance From Taper End Unsignalized Driveway or Signalized Intersection	(0, 500 ft) (SI)	+261.0% (SI)	Commercial driveways in interchange influence areas create conflicts with interchange traffic and insufficient travel distances for vehicles to slow before diverging from or merging with through traffic.

* Variable that is significant in explaining the potential of specific injury severity level listed in the parenthesis.

** Percentage value of influence in increasing (+) or decreasing (-) the risk of specific crash severity level in the parenthesis.

Exploratory Case Studies

(1) John Young Parkway at W. Colonial Drive, Orlando

(2) East Bay Drive (State Road 686), Largo

(3) West Tennessee Street, Tallahassee

(4) State Road 932, Hialeah

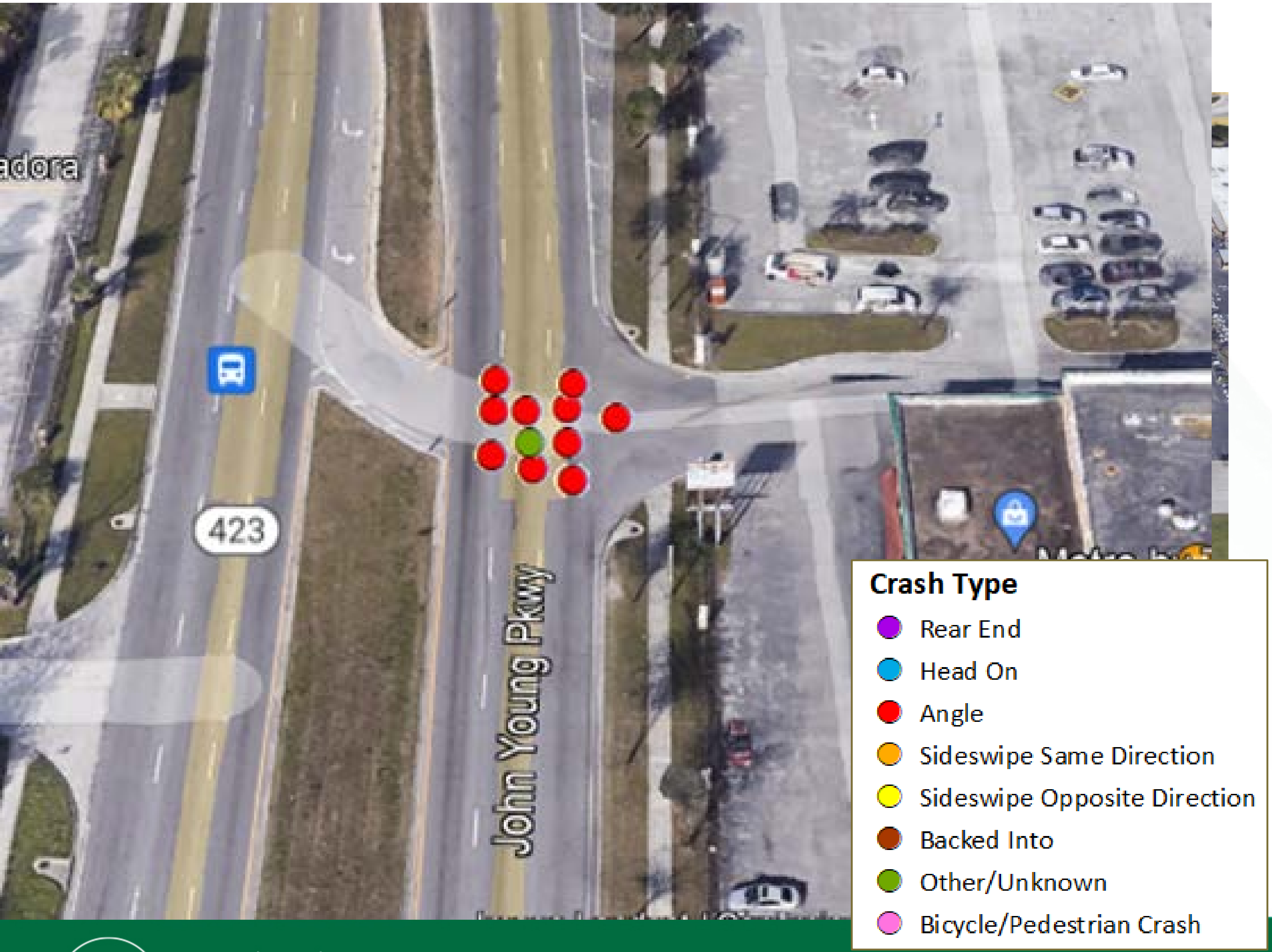
(5) West Hallandale Beach Boulevard at I-95 Interchange

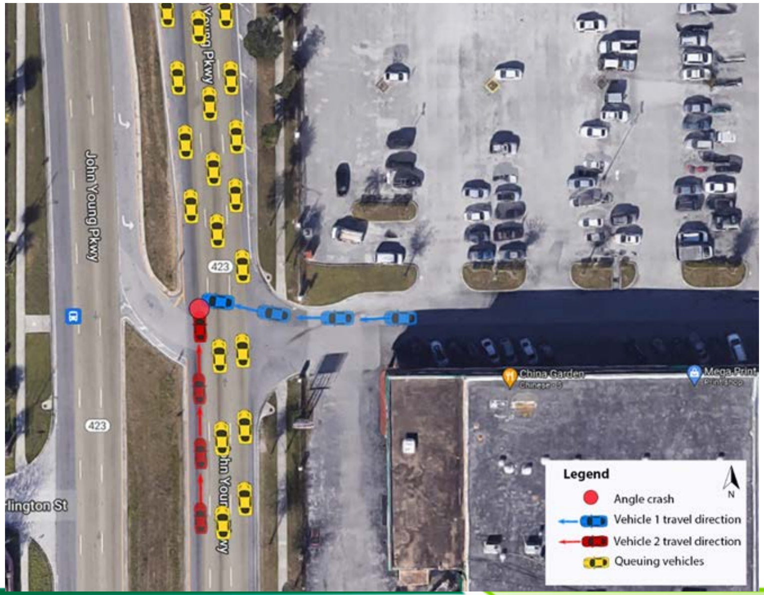
(6) Scenic Highway at I-10 Interchange

Selected Case Study Findings

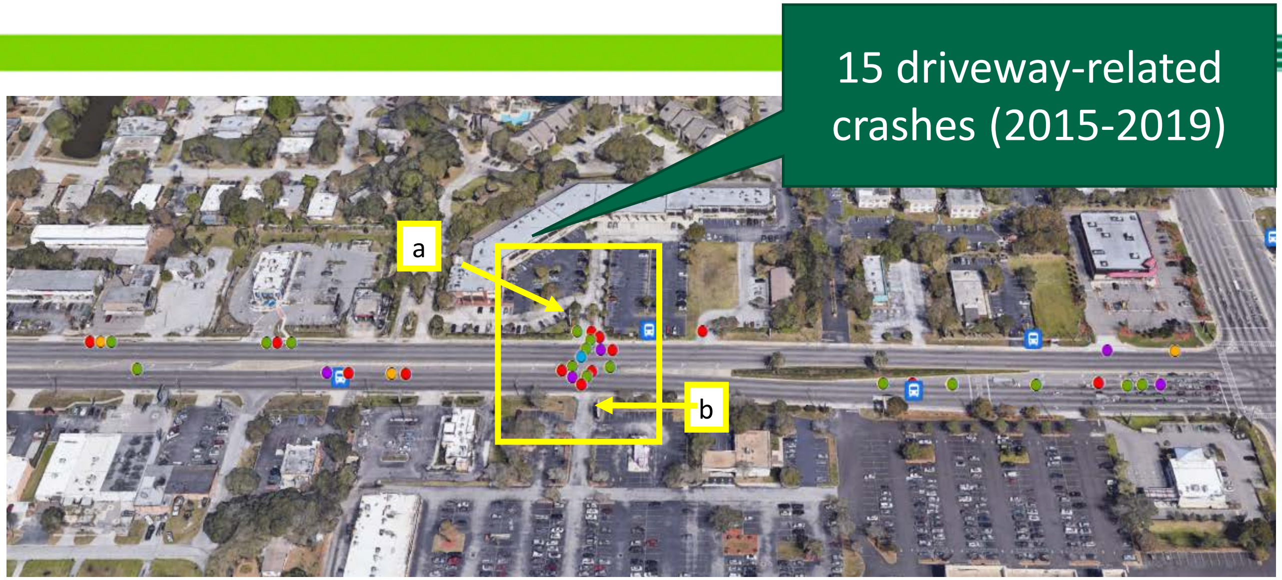
- Allowing commercial driveway access in the functional area of major roadway intersections may still be unsafe, despite mitigating techniques such as nontraversable medians and directional median openings.
- Aligning higher-volume commercial driveways at unsignalized full median openings was observed to result in a variety of conflicts and crashes.
- Closely-spaced high-volume commercial driveways that experience similar peak periods require special attention to ensure that adequate space is provided on-site for circulation and queueing.
- Drivers looking at oncoming traffic while exiting commercial driveways do not notice bicyclists crossing driveways from the opposite direction, resulting in bicycle-involved crashes.
- Commercial driveway access near interchange ramps creates several safety issues.

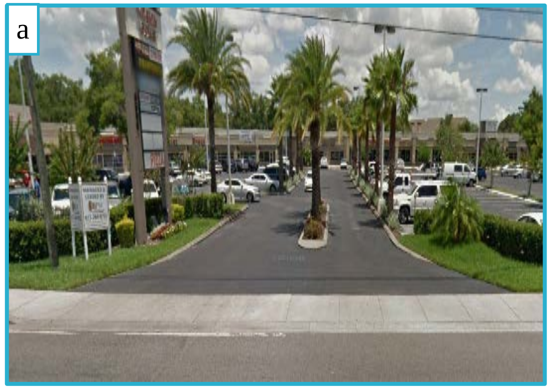
John Young Parkway, Orange County



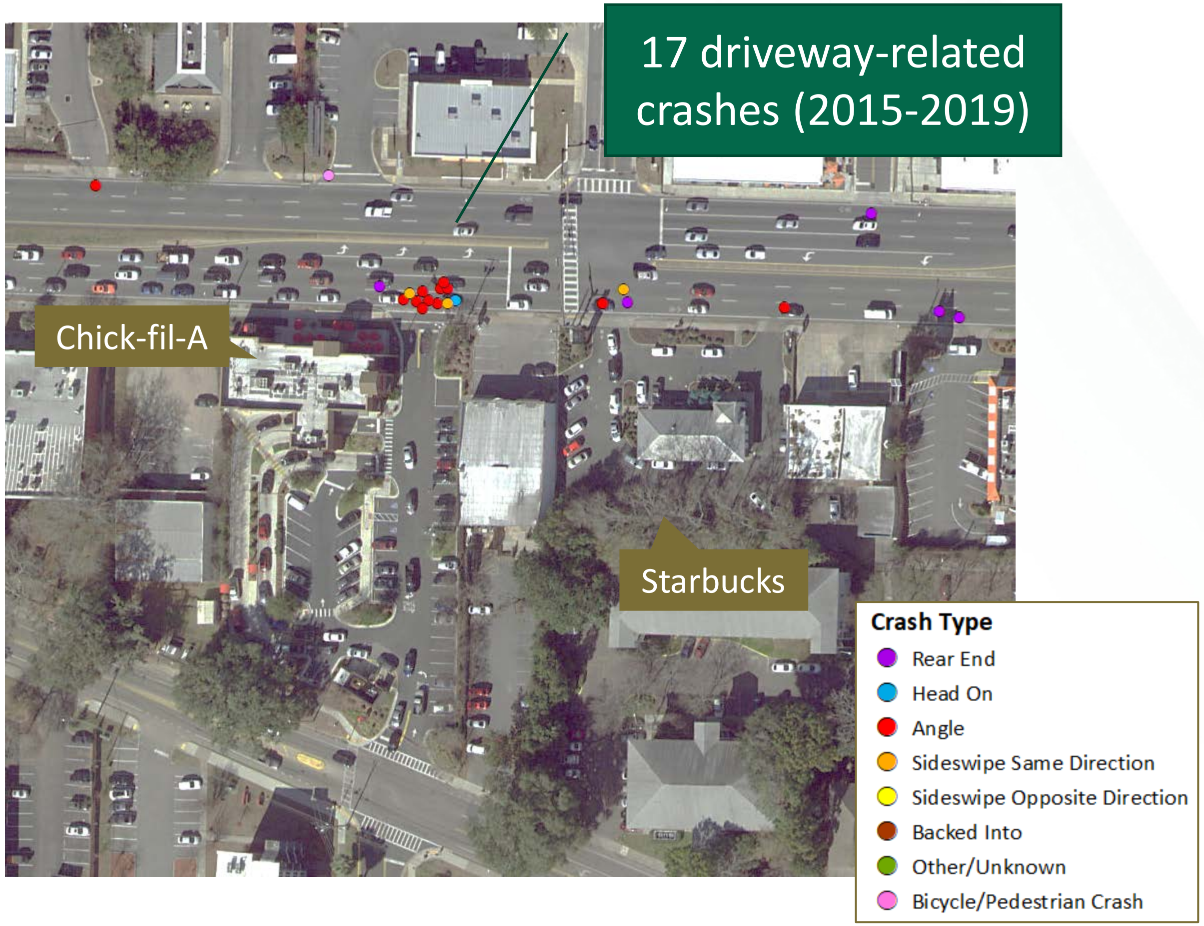


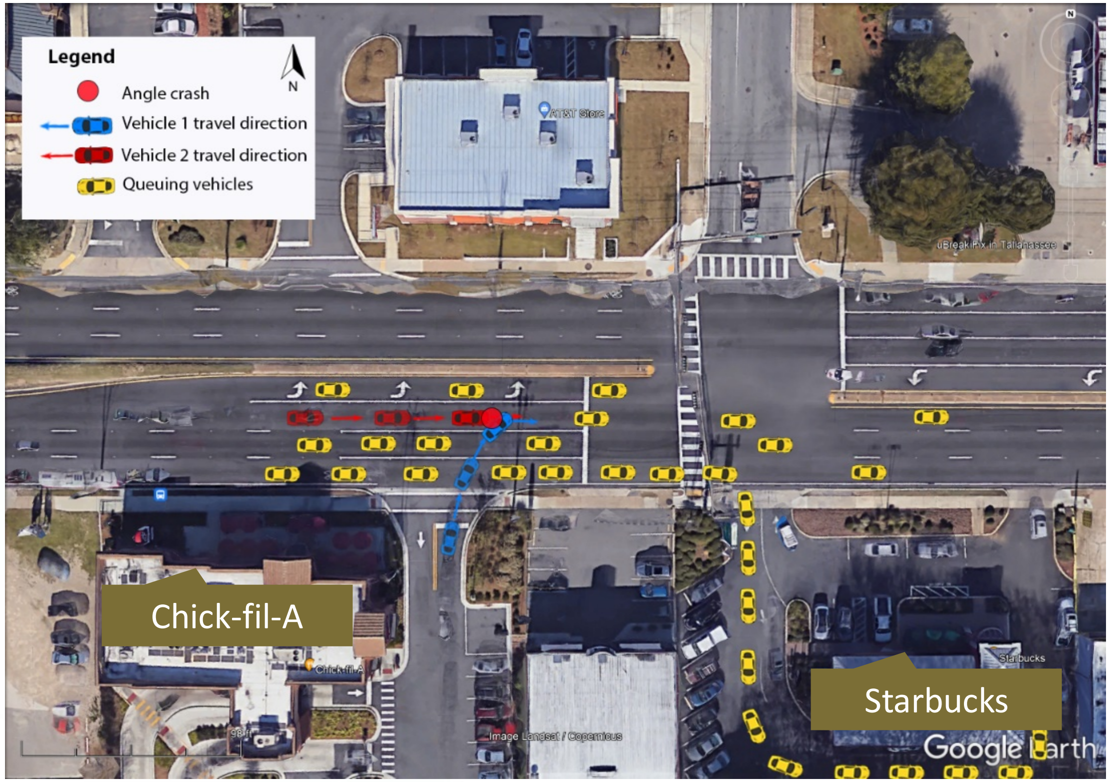
East Bay Drive, Largo



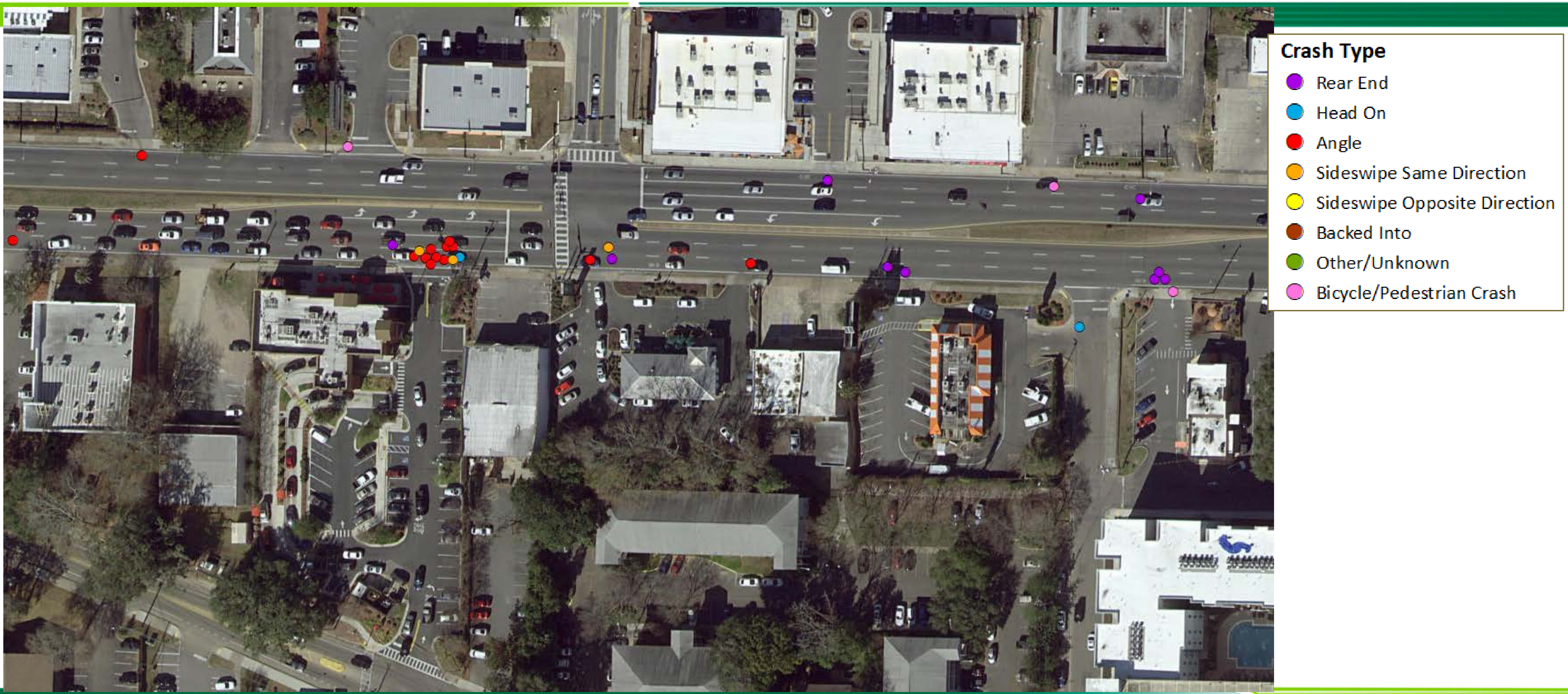


West Tennessee Street, Tallahassee



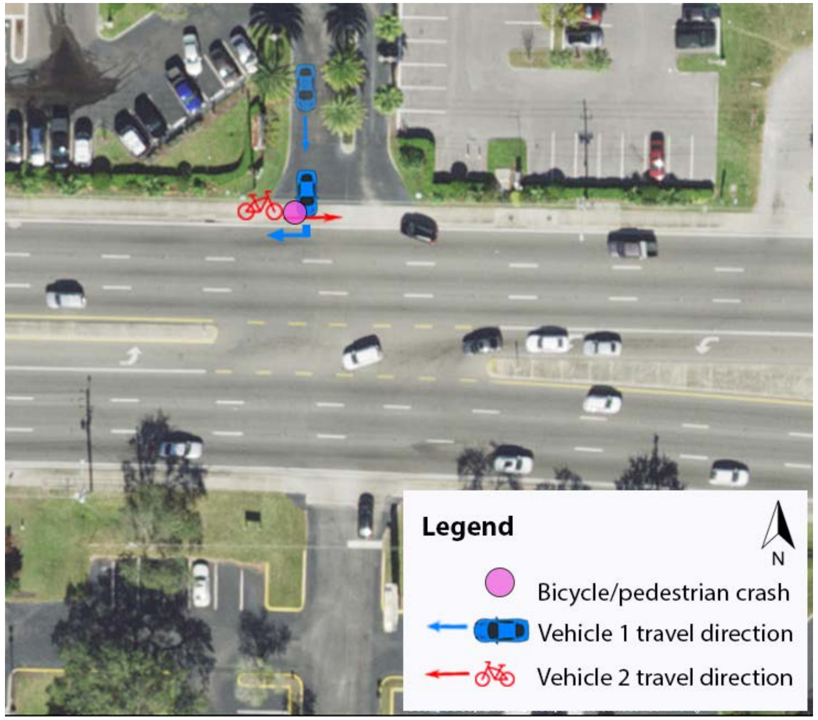


West Tennessee Street, Tallahassee



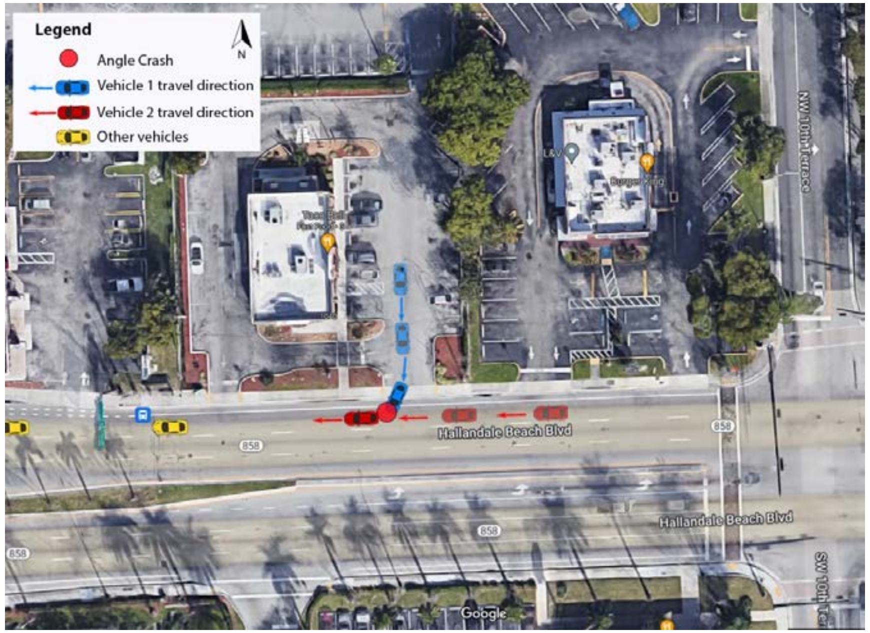
Typical Bicycle Crashes

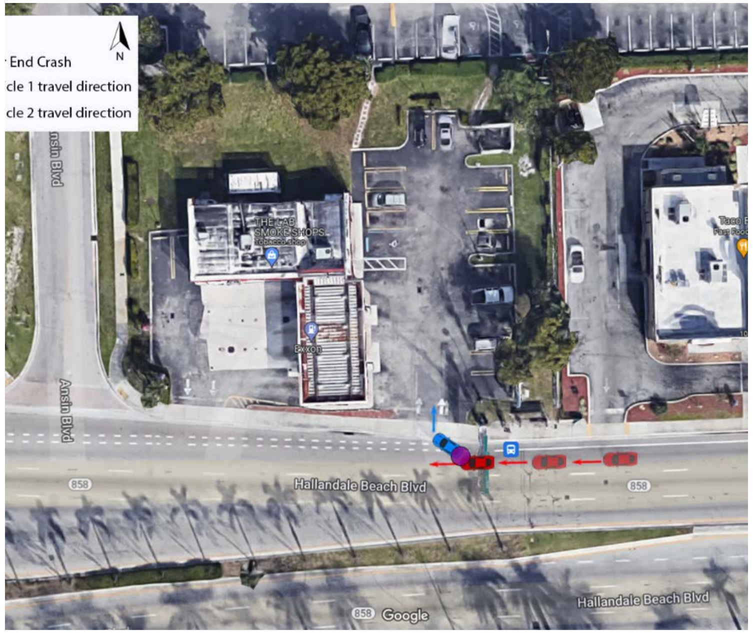
“Wrong way” cyclists hit as drivers look left while exiting driveways

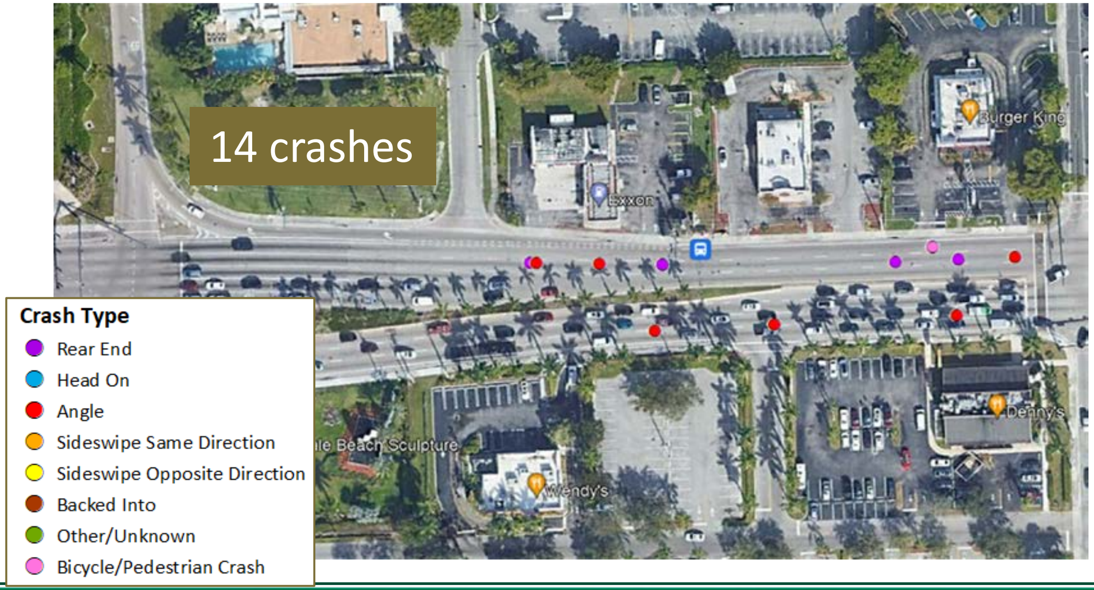


East Bay Drive, Largo

W Hallandale Beach Blvd @ I-95



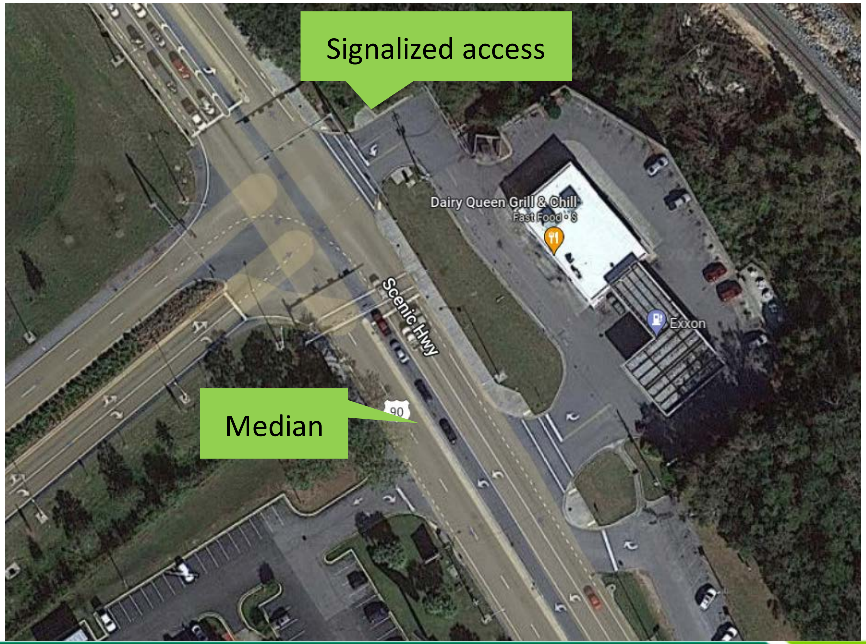




I-95@ W Hallandale Beach Blvd Interchange Area

Scenic Highway @ I-10 Interchange Area

Before reconstruction



After reconstruction

Scenic Highway @ I-10 Interchange Area (Before Reconstruction)

19 driveway-related crashes (2015-2019)

Recommended Guidance Updates

1) Consider using traffic volume and land use context, as well as speed, as primary criteria for minimum driveway spacing.
2) Avoid permitting higher-volume commercial driveways on opposite sides of a roadway at or within close proximity to a full median opening that is not signalized.
3) Carefully consider the crash potential of the "good Samaritan" effect when permitting high-volume commercial driveways in the functional area of intersections or interchanges.
4) Avoid using conventional bike lanes on major roadways with frequent commercial driveway access unless mitigating actions are taken at commercial driveway locations.
5) Prohibit new access in the vicinity of interchange ramps whenever feasible and use policy, design and funding methods to relocate and/or mitigate the effects of such access in existing developed areas.
6) Consider taking a more active role in advancing off-system network development along the state highway system to reduce commercial driveways on major corridors and near highway interchanges for improved safety.

Future Research Consideration

The safety effects of following driveway and traffic characteristics on commercial driveway safety:

- **Traffic Operation Characteristics**
  - Higher posted speed limits on connected street
  - Connected Street 5-year Average AADT
- **Roadway Facility Features**
  - Wide-open access or other driveway design types
  - Traffic control devices on pedestrian/bicycle safety
  - Conventional bike lanes (without a physical separator or surface paint)

For further information:

kristinewilliams@usf.edu

congchen1@usf.edu

www.cutr.usf.edu

Questions

Thank you!

Contact Info

- Gina.Bonyani@dot.state.fl.us
- Jenna.Bowman@dot.state.fl.us
- Karla.Matos@dot.state.fl.us

Thank you!